



US010955802B2

(12) **United States Patent**
Holyoak et al.

(10) **Patent No.:** **US 10,955,802 B2**
(45) **Date of Patent:** **Mar. 23, 2021**

(54) **MECHANICAL INPUT/OUTPUT SELECTOR**

(56) **References Cited**

(71) Applicant: **Raytheon Company**, Waltham, MA (US)
(72) Inventors: **Vonn Holyoak**, Vail, AZ (US); **Samuel R. Nielsen**, Tucson, AZ (US); **Robert E. Munger**, Sonoita, AZ (US)
(73) Assignee: **Raytheon Company**, Waltham, MA (US)

U.S. PATENT DOCUMENTS

2,844,656 A 7/1958 Lohs
4,514,602 A * 4/1985 Owen H01H 9/0005
2003/0000813 A1 * 1/2003 Roos H01H 67/22
200/16 C
2014/0131182 A1 * 5/2014 Leccia H02B 11/02
200/1 R
200/238

FOREIGN PATENT DOCUMENTS

EP 2261935 A1 12/2010
WO WO 2011/076259 A1 6/2011

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 145 days.

OTHER PUBLICATIONS

(21) Appl. No.: **16/110,780**

International Search Report for International Application No. PCT/US2019/037764 dated Sep. 20, 2019, 12 pages.

(22) Filed: **Aug. 23, 2018**

(65) **Prior Publication Data**

US 2020/0064802 A1 Feb. 27, 2020

* cited by examiner

Primary Examiner — Ahmed M Saeed

(51) **Int. Cl.**

G05B 19/042 (2006.01)
H03K 19/17736 (2020.01)
H03K 19/17788 (2020.01)

(57) **ABSTRACT**

A mechanical input/output selector is disclosed. The mechanical input/output selector can include a first terminal for a first transmission line. The mechanical input/output selector can also include a plurality of second terminals for a plurality of second transmission lines. The mechanical input/output selector can further include a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals. Additionally, the mechanical input/output selector can include a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals. Associated systems and methods are also provided.

(52) **U.S. Cl.**

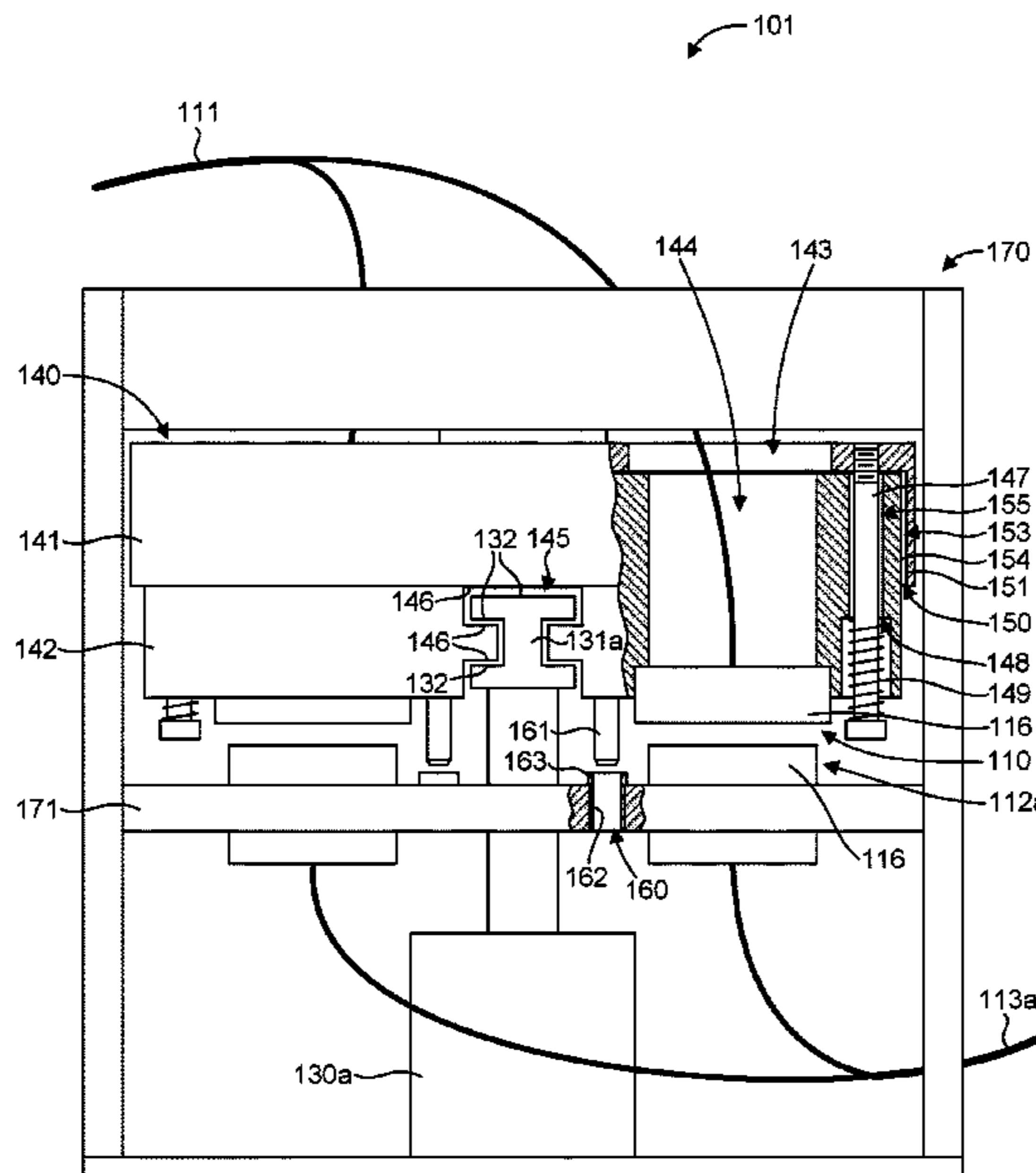
CPC **G05B 19/0423** (2013.01); **G05B 2219/21** (2013.01); **H03K 19/17744** (2013.01); **H03K 19/17788** (2013.01)

(58) **Field of Classification Search**

CPC H01H 63/02; H01H 67/06; H01H 36/006; H01H 63/06; H01H 67/26; H01H 19/563; H01H 9/0027; G05B 19/0423; G05B 2219/21; H03K 19/17744; H03K 19/17788

See application file for complete search history.

19 Claims, 6 Drawing Sheets



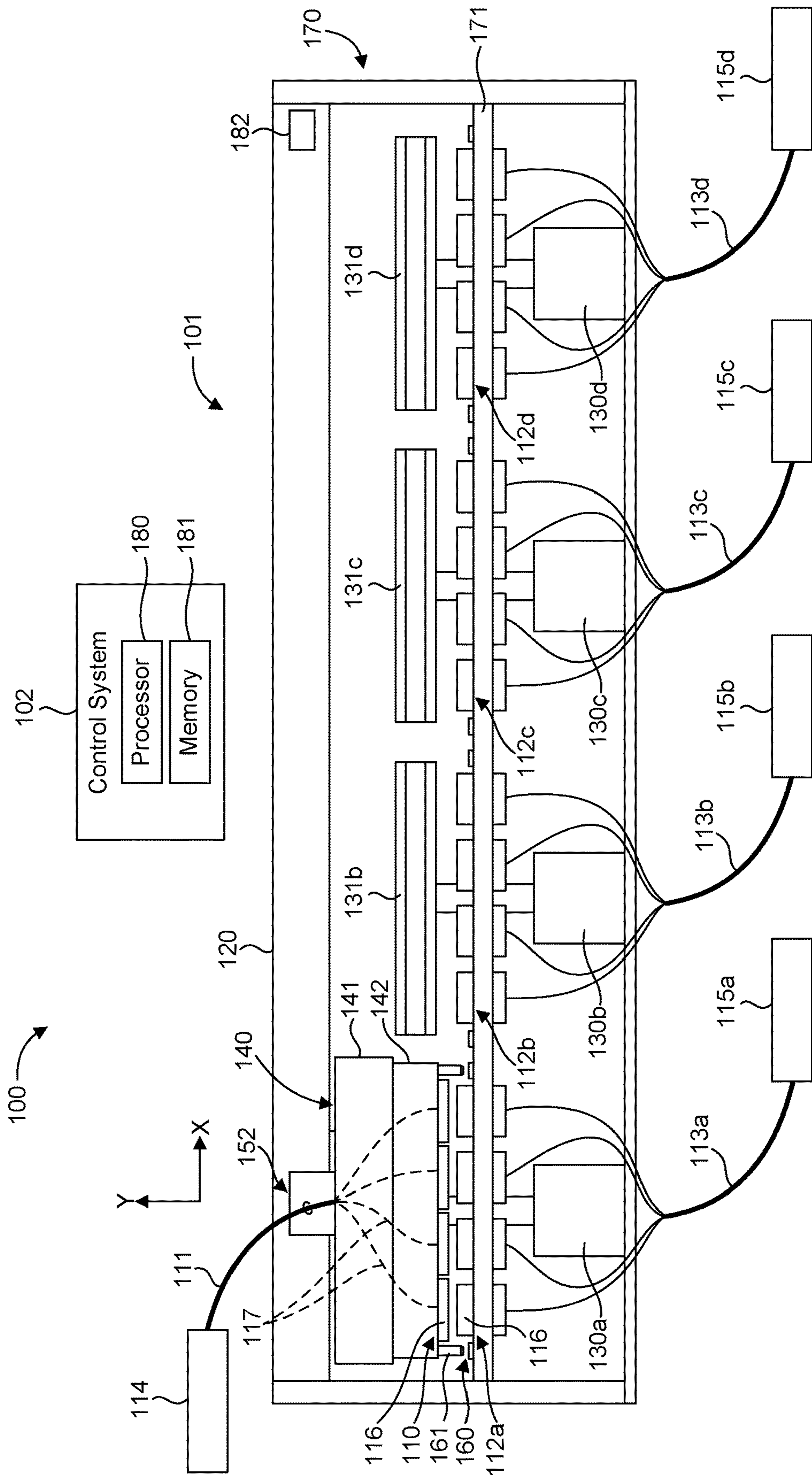


FIG. 1

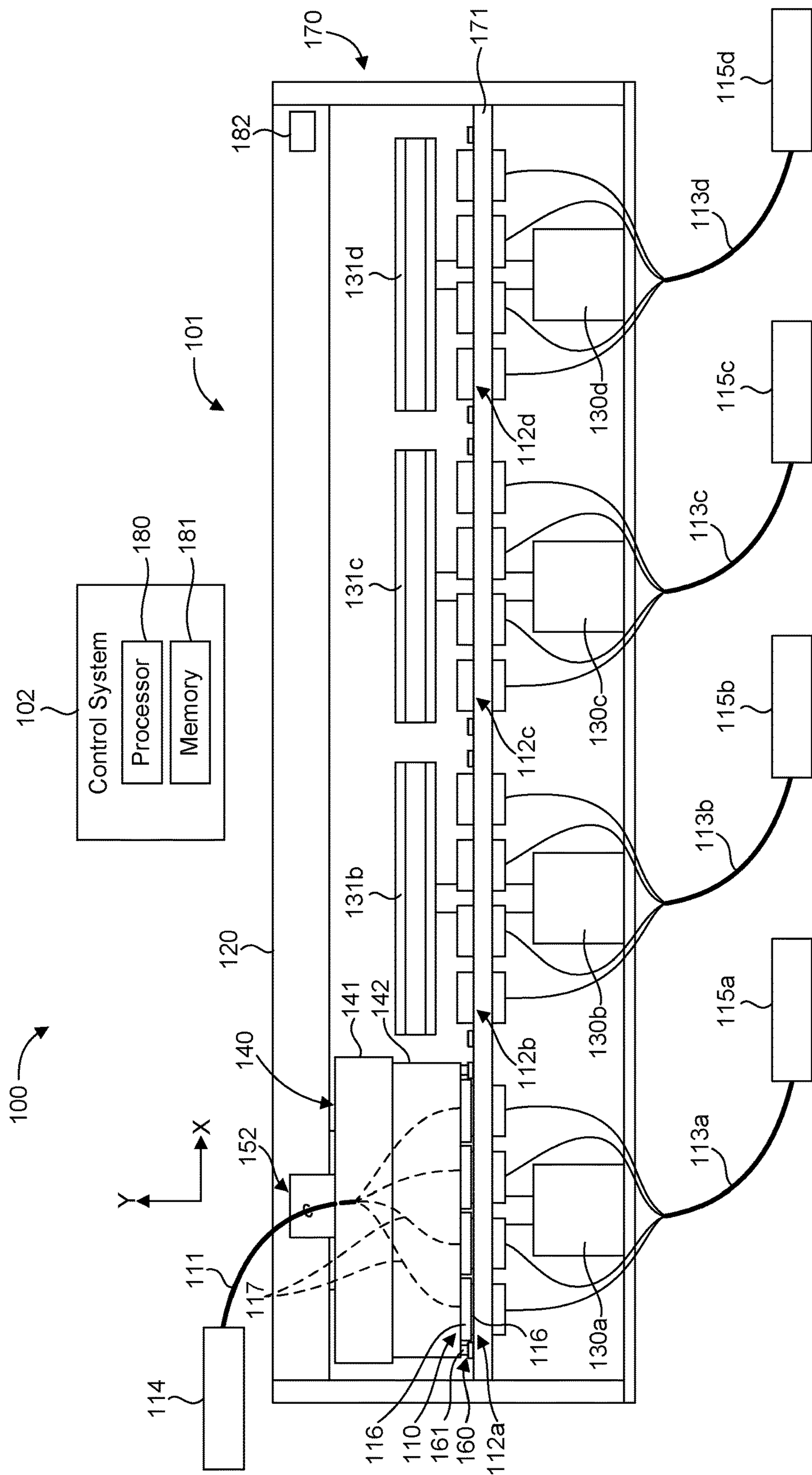


FIG. 2

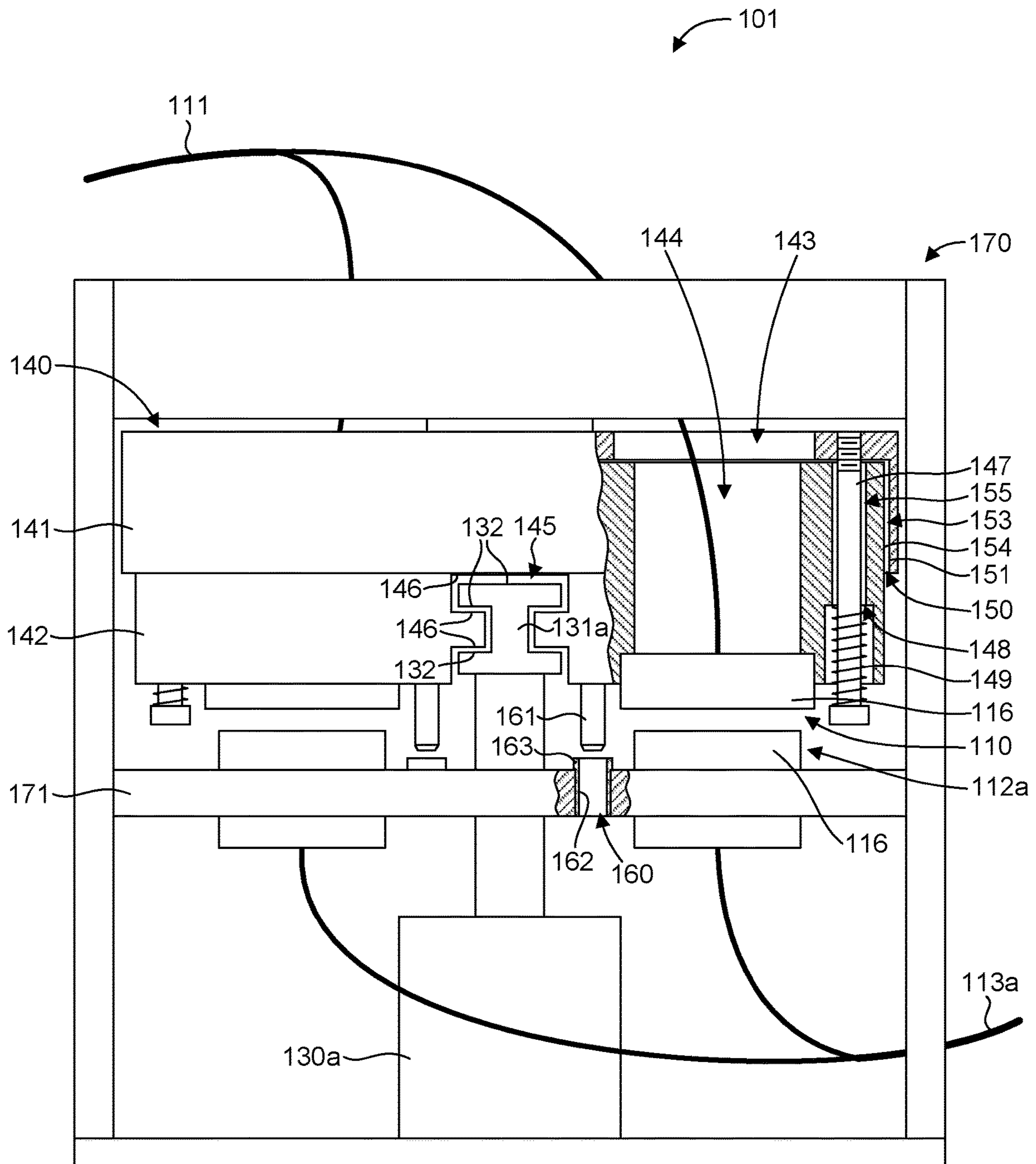


FIG. 3

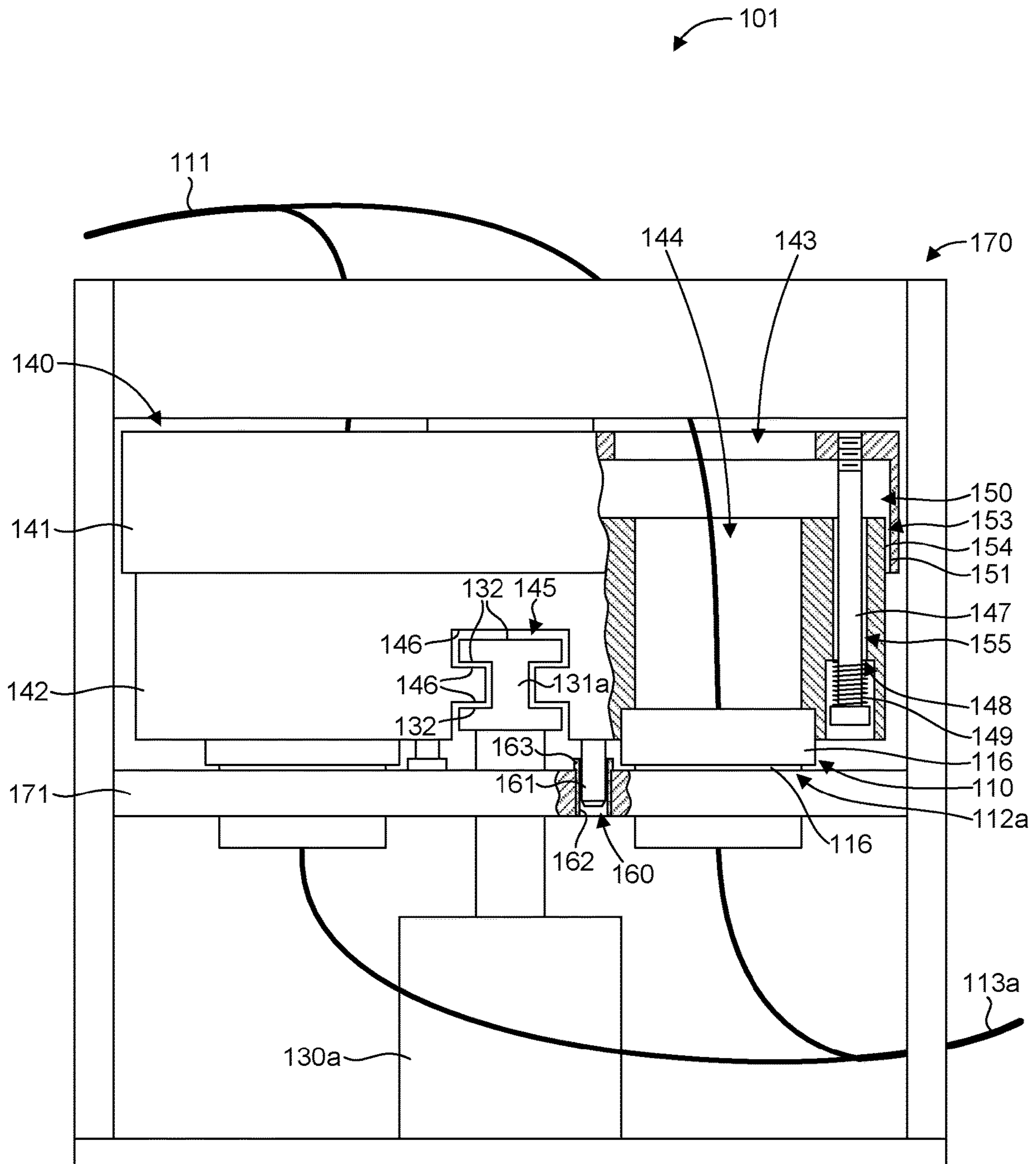


FIG. 4

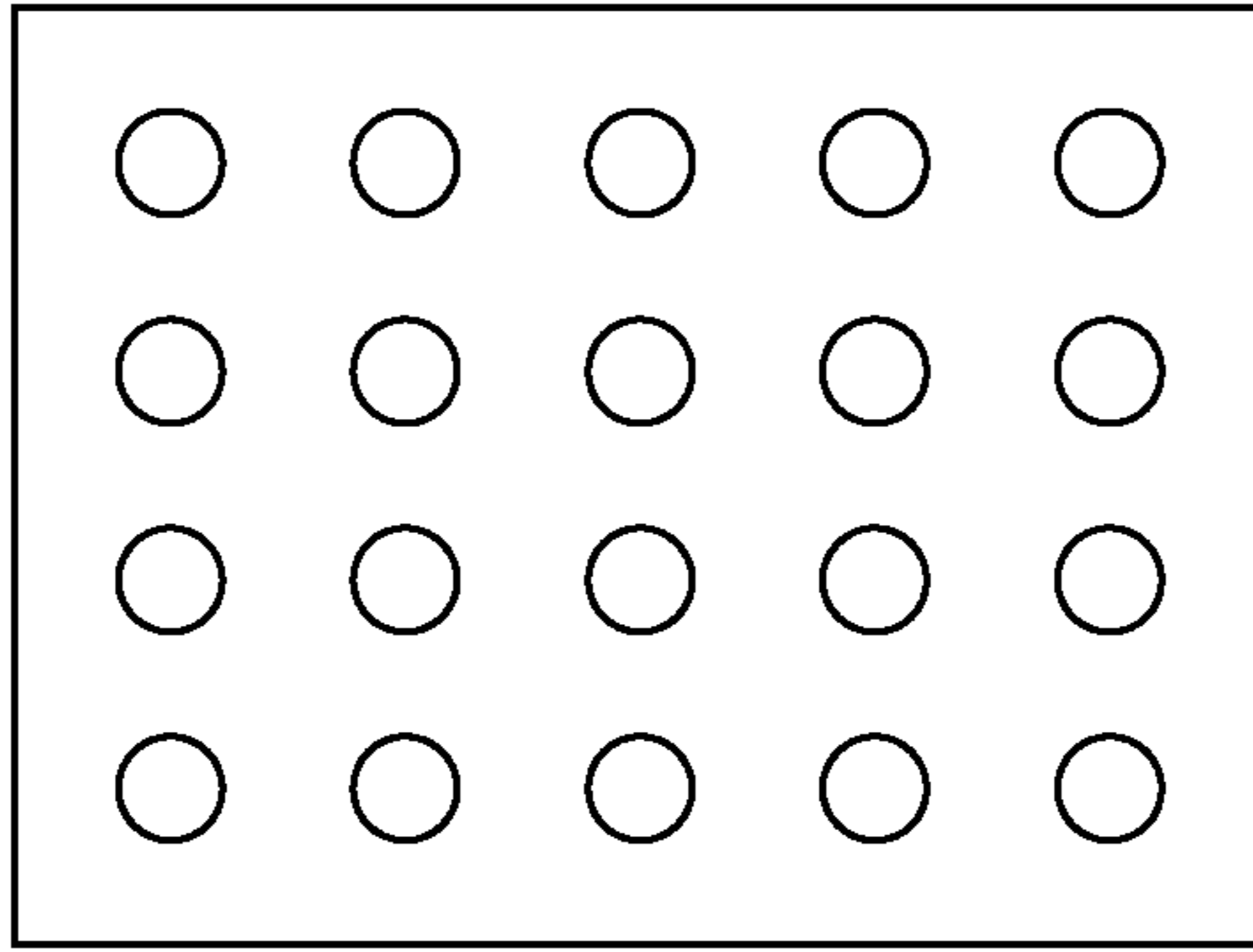


FIG. 5A

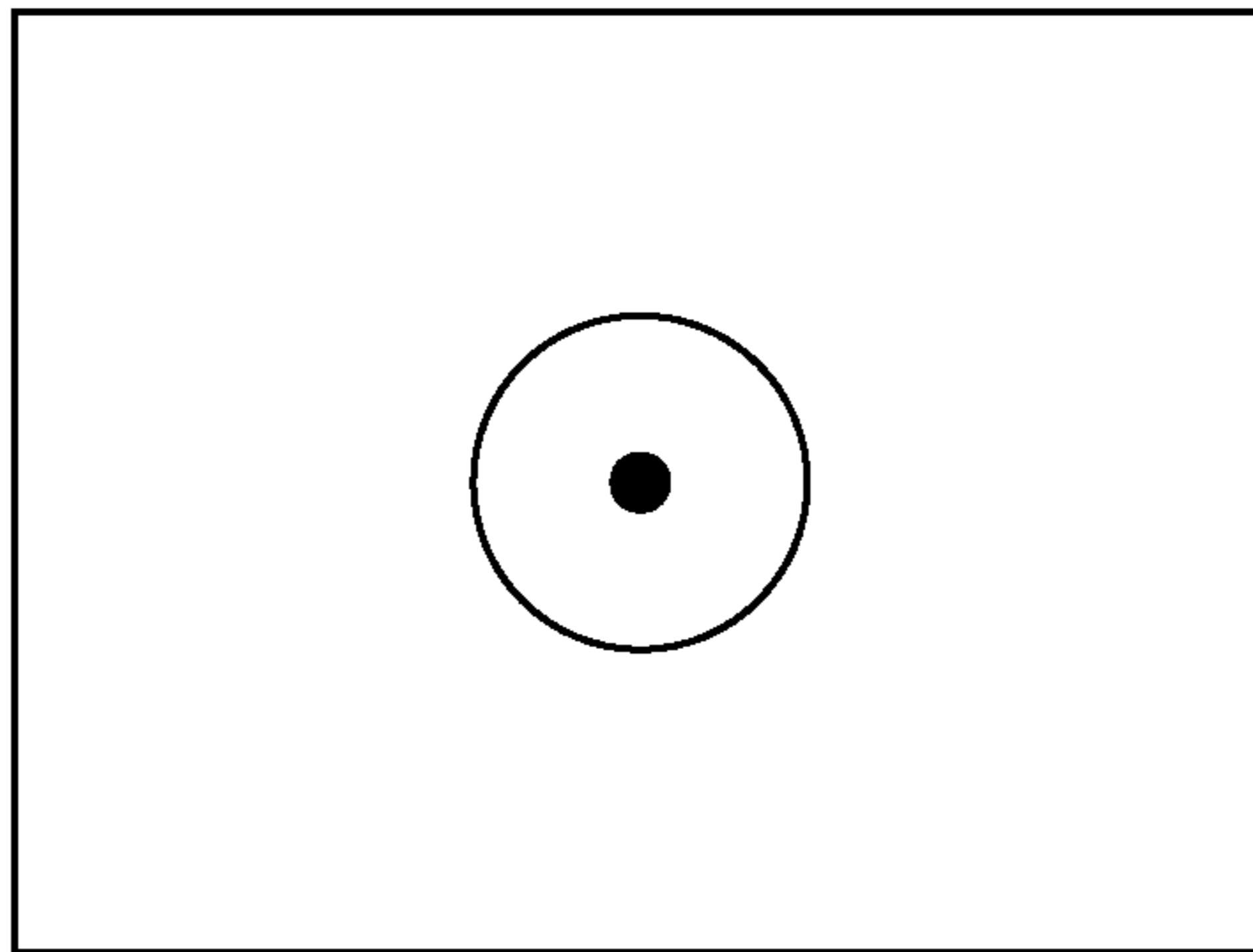


FIG. 5B

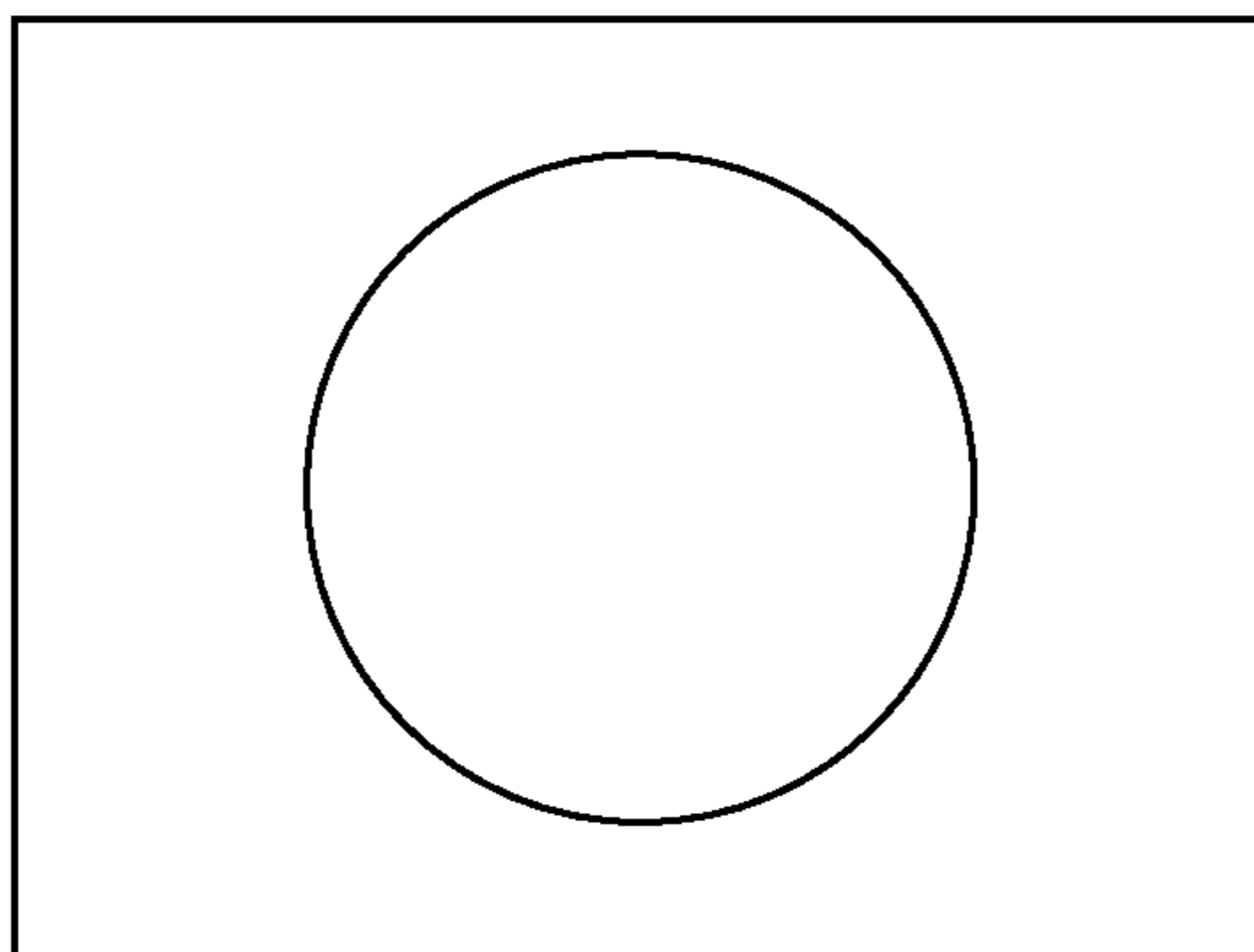


FIG. 5C

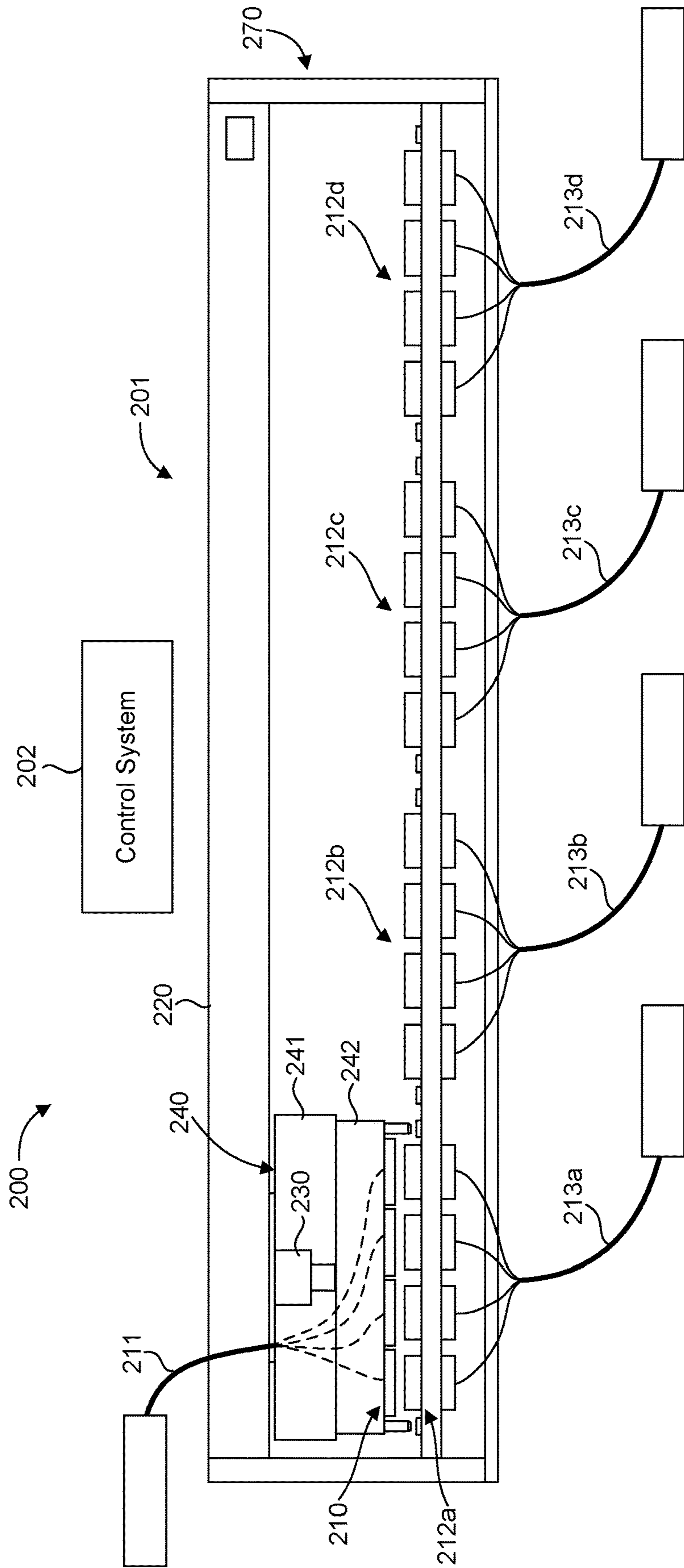


FIG. 6

MECHANICAL INPUT/OUTPUT SELECTOR

BACKGROUND

A wide variety of applications require switching of input/output (I/O) signals and power, which is traditionally accomplished using electrical multiplexers. Some applications require switching of a high volume of signals and high power (i.e., voltage/current), such as for testing various components in a test cell. Electrical multiplexers are capable of switching signal channels but are limited to low power applications. As a result, switching of high power lines typically requires the use of relays to control the path of current to the multiplexers and often requires human intervention. In some of these applications (e.g., testing components isolated in a test cell) autonomous switching is required as human interaction may not be desirable or feasible.

BRIEF DESCRIPTION OF THE DRAWINGS

Features and advantages of the invention will be apparent from the detailed description which follows, taken in conjunction with the accompanying drawings, which together illustrate, by way of example, features of the invention; and, wherein:

FIG. 1 is a side view of a mechanical input/output selector system in a disconnected configuration, in accordance with an example of the present disclosure.

FIG. 2 is a side view of the mechanical input/output selector system of FIG. 1 in a connected configuration, in accordance with an example of the present disclosure.

FIG. 3 is an end view of a mechanical input/output selector of the system of FIG. 1 in a disconnected configuration, in accordance with an example of the present disclosure.

FIG. 4 is an end view of a mechanical input/output selector of the system of FIG. 1 in a connected configuration, in accordance with an example of the present disclosure.

FIGS. 5A-5C illustrate representations of connectors that can be included in a mechanical input/output selector, in accordance with several examples of the present disclosure.

FIG. 6 is a side view of a mechanical input/output selector system in accordance with another example of the present disclosure.

Reference will now be made to the examples illustrated, and specific language will be used herein to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended.

DETAILED DESCRIPTION

As used herein, the term “substantially” refers to the complete or nearly complete extent or degree of an action, characteristic, property, state, structure, item, or result. For example, an object that is “substantially” enclosed would mean that the object is either completely enclosed or nearly completely enclosed. The exact allowable degree of deviation from absolute completeness may in some cases depend on the specific context. However, generally speaking the nearness of completion will be so as to have the same overall result as if absolute and total completion were obtained. The use of “substantially” is equally applicable when used in a negative connotation to refer to the complete or near complete lack of an action, characteristic, property, state, structure, item, or result.

As used herein, “adjacent” refers to the proximity of two structures or elements. Particularly, elements that are identified as being “adjacent” may be either abutting or connected. Such elements may also be near or close to each other without necessarily contacting each other. The exact degree of proximity may in some cases depend on the specific context.

An initial overview of the inventive concepts are provided below and then specific examples are described in further detail later. This initial summary is intended to aid readers in understanding the examples more quickly, but is not intended to identify key features or essential features of the examples, nor is it intended to limit the scope of the claimed subject matter.

As mentioned above, electrical multiplexers can be effectively utilized for signal switching and low power applications but require relays to enable use in high power applications. High volume multiplexing applications require additional electrical cables and can give rise to cable management and space concerns, which may preclude the use of electrical multiplexers in some applications. In addition, electrical multiplexers suffer from signal degradation and the control mechanisms are complex. While mechanical mass interconnects may avoid these cable management and space issues as well as the signal degradation concerns related to electrical multiplexers, mechanical interconnects require human intervention to perform the switching, which may not be desirable or feasible.

Accordingly, a mechanical input/output selector is disclosed that can mechanically switch high power lines and a high number of signal lines simultaneously. In one aspect, the mechanical input/output selector can perform the switching autonomously and without human intervention. The mechanical input/output selector can include a first terminal for a first transmission line. The mechanical input/output selector can also include a plurality of second terminals for a plurality of second transmission lines. The mechanical input/output selector can further include a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals. Additionally, the mechanical input/output selector can include a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals.

A mechanical input/output selector system is also disclosed. The mechanical input/output selector system can comprise a mechanical input/output selector. The mechanical input/output selector can include a first terminal for a first transmission line. The mechanical input/output selector can also include a plurality of second terminals for a plurality of second transmission lines. The mechanical input/output selector can further include a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals. In addition, the mechanical input/output selector can include a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals. The mechanical input/output selector system can also comprise a control system to control operation of the first and second displacement devices.

To further describe the present technology, examples are now provided with reference to the figures. With reference to FIG. 1, one example of a mechanical input/output selector system **100** is illustrated. The system **100** can comprise a

mechanical input/output selector **101**, and a control system **102** to control operation of the selector **101**.

The mechanical input/output selector **101** can include a terminal **110** for a transmission line **111**, and terminals **112a-d** for respective transmission lines **113a-d**. The transmission lines **111**, **113a-d** can be coupled to respective devices **114**, **115a-d**, which can be of any suitable type (e.g., electronic, mechanical, electromechanical, pneumatic, hydraulic, etc. alone or in any combination). In one example, the device **114** can be an output device and the devices **115a-d** can be input devices that receive input from the output device **114**. For example, the devices **115a-d** can be test devices or platforms and the device **114** can provide input to perform tests on the test devices **115a-d**.

As described in more detail below, the terminal **110** can be physically engaged with and disengaged from the terminals **112a-d** to selectively couple the transmission line **111** with any of the transmission lines **113a-d**. FIG. 1 shows the terminal **110** disconnected from the terminals **112a-d**. FIG. 2 shows the terminal **110** connected to one of the terminals **112a-d**, specifically, the terminal **112a**. FIGS. 3 and 4 show end views of the selector **101** with terminals in disconnected and connected configurations, respectively.

The transmission lines **111**, **113a-d** can be of any suitable type (e.g., an electrical cable (e.g., for power, signals, and/or data transfer), an optical cable (e.g., for signal and/or data transfer), a hydraulic hose (e.g., for pressurized hydraulic fluid, coolant, etc.), a pneumatic hose (e.g., for pressurized gas, a vacuum line, etc.), etc. in any combination). In some examples, the transmission lines **111**, **113a-d** can include a bundle of similar or dissimilar transmission lines. The terminals **110**, **112a-d** can each comprise one or more connectors **116** adapted to operably couple the transmission line **111** to one or more of the transmission lines **113a-d**. The connectors **116** can be of any suitable type, such as an electrical connector, a fluid connector (e.g., a pneumatic connector, a hydraulic connector, etc.), a fiber optic connector, etc. FIGS. 5A-5C illustrate representations of an electrical pin connector, a coaxial connector, and a fluid connector (e.g., a pneumatic or hydraulic connector), respectively. The connectors contemplated herein can be of any suitable type or design known in the art or a customized design. Although not explicitly illustrated, it should be recognized that the connectors can include securing features and/or mechanisms for actuating such securing features. For example, a pneumatic connector may include a securing ring typically found in “quick connect” pneumatic connectors and the connector may include an actuator operable to engage/disengage the securing ring.

With further reference to FIGS. 1 and 2, in one aspect, a transmission line can comprise multiple lines **117**, which can be of the same or different types of cables, hoses, etc. Accordingly, the various terminals **110**, **112a-d** can comprise any suitable type of connector **116** operable to connect a given type of cable, hose, etc. In one aspect, the transmission lines **113a-d** and the respective terminals **112a-d** may include the same or a different combination of cables or hoses and associated connectors than that of another one. In addition, the transmission line **111** and the terminal **110** can include the types of cables and associated connectors found among the transmission lines **113a-d** and the respective terminals **112a-d** to enable coupling the terminal **110** to any one of the terminals **112a-d**. For example, the transmission line **113a** can include only a power cable, an electrical data transfer cable, and a hydraulic hose with the terminal **112a** having the appropriate connectors for making connections with these types of cables and hoses. The transmission line

113b can include only a power cable and an optical data transfer cable with the terminal **112b** having the appropriate connectors. In this case, the transmission line **111** can include an electrical power cable, an electrical data transfer cable, an optical data transfer cable, a hydraulic hose, and a pneumatic hose with the terminal **110** having the appropriate connectors. When the transmission line **111** is coupled to the transmission line **113a** via the respective terminals **110**, **112a**, the electrical power cables, the electrical data transfer cables, and the hydraulic hoses of the transmission lines **111**, **113a** can be coupled to one another, while the optical data transfer cable and the pneumatic hose of the transmission line **111** remain uncoupled due to the absence of these types of cables and hoses in the transmission line **113a** and of mating connectors in the terminal **112a**. When the transmission line **111** is coupled to the transmission line **113b** via the respective terminals **110**, **112b**, the electrical power cables and the optical data transfer cables of the transmission lines **111**, **113a** may be coupled to one another, while the electrical data transfer cable, the hydraulic hose, and the pneumatic hose of the transmission line **111** remain uncoupled due to the absence of these types of cables and hoses in the transmission line **113b** and of mating connectors in the terminal **112b**. The terminal **110** can therefore be configured to accommodate every type of transmission line connected to the various terminals **112a-d** even if the terminals **112a-d** differ in some way.

A selector device in accordance with the present technology can therefore be used to provide connections of various types of transmission lines (e.g., electrical, optical, hydraulic, pneumatic, etc.) in any combination. Thus, transmission lines of “physical” media (e.g., hydraulic, pneumatic, etc.) can be connected/disconnected by the same mechanism and at the same time as electrical or optical transmission lines.

In some examples, the terminals **112a-d** and associated respective transmission lines **113a-d** can serve as “input” channels (e.g., from multiple output devices **115a-d**), and the terminal **110** and associated transmission line **111** can serve as an “output” channel (e.g., to an input device **114**). Thus, one of the several input channels can be selected for coupling with a single output channel. In this case, the selector **101** can function in a manner similar to an electronic multiplexer (e.g., a “mux”), which may serve as a type of multiple-input, single-output switch making it possible for several output sources **115a-d** to share one device **114**. Conversely, the terminal **110** and associated transmission line **111** can serve as an “input” channel (e.g., from an output device **114**), and the terminals **112a-d** and associated respective transmission lines **113a-d** can serve as “output” channels (e.g., to input devices **115a-d**). Thus, one of the several output channels can be selected for coupling with a single input channel. In this case, the selector **101** can function in a manner similar to an electronic demultiplexer (e.g., a “demux”), which may serve as a type of single-input, multiple-output switch making it possible for one output source **114** to serve several devices **115a-d**. In some examples, multiple selectors **101** can be coupled together with one selector functioning as a multiplexer and another selector functioning as a demultiplexer. It should be recognized that designating “input” and “output” channels does not dictate that the direction of transmissions through the channels is necessarily from “input” to “output.” Depending on the application, transmissions may be conveyed through “input” and “output” channels in any direction (i.e., from “input” to “output” and/or from “output” to “input,” e.g., for two-way communication).

One aspect of the present technology is mechanical connection/disconnection (i.e., physical engagement/disengagement) of the terminal **110** and the terminals **112a-d**. For electrical connections, such mechanical engagement can enable better control of signal integrity compared to that available from an electronic switch (e.g., switching via electronic circuitry), because a mechanical connection provides only a single interface of conductors where degradation can occur, while an electronic switch has many switches in its circuitry that degrade signals. As a result, the mechanical connections of the present technology can provide superior signal to noise ratio (SNR) compared to electronic switches.

The mechanical input/output selector **101** can include a selection displacement device **120** operable to selectively position the terminal **110** proximate to any one of the terminals **112a-d**. In the illustrated example, the terminals **112a-d** can be linearly arranged in a direction parallel to an X-axis, and the displacement device **120** can be configured to move in a direction parallel to the X-axis (e.g., horizontally) to position the terminal **110** proximate to any one of the terminals **112a-d**. For example, the displacement device **120** can position the terminal **110** at the same X-axis coordinate as any one of the terminals **112a-d**, which in the illustrated example is vertically above the terminals **112a-d**.

The mechanical input/output selector **101** can also include one or more connection displacement devices **130a-d** operable to move the terminal **110** relative to the respective terminals **112a-d** to alternately connect and disconnect the terminal **110** and one of the terminals **112a-d**. In the illustrated example, the displacement devices **130a-d** can be configured to move in a direction parallel to a Y-axis, which is orthogonal to the X-axis, to vertically position the terminal **110** to connect and disconnect the terminal **110** and one of the terminals **112a-d**, as explained in more detail below.

The displacement devices **120**, **130a-d** can be or include any suitable type of device or mechanism that can cause relative displacement between two bodies. In some examples, one or more of the displacement devices **120**, **130a-130d** can comprise a linear actuator, such as a linear positioning system, an electric actuator, a hydraulic actuator, a pneumatic actuator, etc. Although the terms “horizontal” and “vertical” have been used herein to describe operation of the displacement devices **120**, **130a-d**, it should be recognized that these terms have been used in a relative context applicable to the illustrations.

With further reference to FIGS. **1** and **2**, and particular reference to FIGS. **3** and **4**, in one aspect the mechanical input/output selector **101** can include a carriage **140** coupled to the displacement device **120** and that supports the terminal **110**. The carriage **140** can be moved by the displacement device **120** to position the terminal **110** relative to the terminals **112a-d** along the X-axis. In the illustrated example, the carriage **140** can comprise a base **141** coupled (e.g., directly coupled) to the displacement device **120**. The carriage **140** can also comprise a movable platform **142** movably coupled to the base **141** to facilitate movement of the movable platform **142** parallel to the Y-axis. The movable platform **142** can be coupled to the terminal **110** (e.g., directly coupled) and can support the terminal **110**. The movable platform **142** can therefore position the terminal **110** relative to the terminals **112a-d** along the Y-axis to connect and disconnect the terminal **110** and one of the terminals **112a-d**. In some examples, the movable platform **142** can be configured to fit at least partially within a platform opening **150** of the base **141**. The platform opening **150** can be at least partially defined by base sidewalls **151**.

The base **141** and the movable platform **142** can also include respective transmission line openings **143**, **144** to facilitate routing the transmission line **111** through the carriage **140** to the terminal **110**. A transmission line guide **152** can be coupled to the base **141** (as shown in FIGS. **1** and **2**) or to the movable platform **142** support and guide the transmission line **111** to prevent excessive bending of the transmission line **111** (i.e., serve as a strain relief) and prevent rubbing of the transmission line **111** on neighboring components, such as the displacement device **120**. The transmission line **111** can be coupled to the transmission line guide **152** in any suitable manner, such as with a clip, cable tie, band, wire, etc.

In the illustrated example, the movable platform **142** can be movable relative to the base **141** by the displacement devices **130a-d**, each of which is associated with one of the terminals **112a-d**. For example, the movable platform **142** can have an interface opening **145**. The displacement devices **130a-d** can include or be coupled to respective platform interfaces **131a-d** configured to be received within the interface opening **145** to facilitate coupling the displacement devices **130a-d** with the movable platform **142**. The platform interfaces **131a-d** can have any suitable configuration (e.g., a rail, bar, or rod configuration). The interface opening **145** can have any suitable complementary or mating configuration operable to receive and interface with the platform interfaces **131a-d**. For example, the platform interfaces **131a-d** can have one or more platform interface surfaces **132**, as shown in FIGS. **3** and **4**. In the illustrated example, the platform interface surfaces **132** serve to define an I-beam cross-section of the platform interfaces **131a-d**. The interface opening **145** can have one or more displacement device interface surfaces **146** configured to interface with (e.g., bear against) the platform interface surfaces **132**. The configuration of platform interface surfaces **132** and displacement device interface surfaces **146** can enable the displacement devices **130a-d** to impart force on the movable platform **142** to cause bi-directional movement of the movable platform **142**. Thus, the displacement devices **130a-d** can draw the movable platform **142** toward the respective terminals **112a-d** for connecting with the terminal **110**, and the displacement devices **130a-d** can push the movable platform **142** away from the respective terminals **112a-d** for disconnecting from the terminal **110**.

In some examples, the movable platform **142** can be biased toward the base **141**. For example, the movable platform **142** and the base **141** can be coupled to one another by one or more fasteners **147** (e.g., bolts, screws, etc.), which can extend through fastener openings **148** in the movable platform **142** and can be secured to the base **141** (e.g., by threaded coupling features). The fasteners **147** can capture a spring **149** (e.g., a compression spring), which can bear against the movable platform **142**. The spring **149** can be configured to provide a biasing force against the movable platform **142** sufficient to maintain the movable platform **142** against the base **141** in the absence of external forces provided by the displacement devices **130a-d**. In some examples, the spring **149** can be preloaded. In some examples, the spring **149**, the fastener **147**, and the movable platform **142** can be configured to facilitate a range of motion of the movable platform **142** relative to the base **141** sufficient to engage the terminal **110** with the terminals **112a-d** without fully compressing the spring **149**.

In one aspect, the selector **101** can be configured to facilitate correct alignment when connecting the terminal **110** and one of the terminals **112a-d**. For example, one or more guide openings **160** can be associated with and posi-

tioned relative to one or more of the terminals **112a-d**, and one or more guide pins **161** can be associated with and positioned relative to the terminal **110**. The guide pins **161** can be configured to fit within the guide openings **160** and interface with a sidewall **162** of the guide openings **160**. The relative size of the guide pins **161** and guide openings **160**, as well as the relative position of the guide pins **161** to the terminal **110** and of the guide openings **160** to the terminals **112a-d** can be configured to ensure proper alignment of the terminal **110** with the terminals **112a-d**. In some examples, the guide pins **161** can include a chamfered tip to facilitate engagement of the guide pins **161** with the guide opening sidewall **162**. In addition, or as an alternative, an entrance portion of the guide opening **160** can include a chamfered sidewall (not shown) to facilitate engagement of the guide pins **161** with the guide opening sidewall **162**. A lateral gap **153** between the base sidewalls **151** and a side surface **154** of the movable platform **142** and a lateral gap **155** between the fastener **147** and a sidewall of the fastener opening **148** can enable enough free lateral motion between the movable platform **142** and the base **141** to allow the interaction between the guide pins **161** and the guide opening sidewall **162** to establish the lateral position of the movable platform **142** and therefore establish proper alignment of the terminal **110** with the terminals **112a-d** when coupling. In one aspect, the guide pins **161** can be configured to enter the guide openings **160** and engage the guide opening sidewall **162** prior to contact between the terminal **110** and the terminals **112a-d** to ensure proper alignment of the terminals and avoid damage. Thus, the displacement device **120** can provide “rough” positioning of the terminal **110** relative to the terminals **112a-d** in the X-axis, and the guide pins **161** and guide openings **160** can provide precise alignment of the terminal **110** relative to the terminals **112a-d** in the X-axis while a given displacement device **130a-d** moves the terminal **110** into engagement with a respective terminal **112a-d**.

In one aspect, the selector **101** can include a support frame **170**. The support frame **170** can serve to support various components of the system **100**, such as the displacement device **120**, the displacement devices **130a-d**, and the terminals **112a-d**. In one example, the support frame **170** can include a support plate **171** to which the displacement devices **130a-d** are mounted. The support frame **170** can position the displacement device **120** above the support plate **171**, with space between to accommodate the carriage **140** and travel of the movable platform **142** relative to the base **141** for connecting/disconnecting the terminal **110** and the terminals **112a-d**. The support frame **170** can also be configured to support the displacement devices **130a-d** and position the support plate **171** generally above the displacement devices **130a-d**. The support plate **171** can include holes or openings (not shown) such that portions of the displacement devices **130a-d** can extend through the support plate **171** to facilitate engagement with the movable platform **142** via the platform interfaces **131a-d**.

In the illustrated example, the guide openings **160** can be associated with the support frame **170** (i.e., the support plate **171**), and the guide pins **161** can be associated or otherwise included with the movable platform **142**. In some examples, the guide openings **160** can be defined by guide bushings **163**, which can be mounted on the support plate **171**. Although the guide pin **161** is shown associated with the movable platform **142**, and the guide opening **160** is associated with the support frame **170**, it should be recognized

that a guide opening can be associated with the movable platform **142** and a guide pin can be associated with the support frame **170**.

In one aspect, the control system **102** can control operation of the displacement devices **120**, **130a-d**. The control system **102** can include any suitable hardware (e.g., a processor **180** and memory **181**), software, etc. typically used in control systems to enable open loop and/or closed loop control of the displacement devices **120**, **130a-d**. For example, the control system **102** can be configured to provide “servo” control of the displacement device **120**. The system **100** can include a position sensor **182** to provide position feedback data (e.g., position data of the displacement device **120**) for the control system **102** to position the terminal **110** relative to the various terminals **112a-d**. In one example, the displacement devices **120**, **130a-d** comprise pneumatic actuators, and the control system **102** comprises a servo pneumatic controller that can provide servo control of the displacement device **120** as well as solenoid valve control of the displacement devices **130a-d** to position the terminal **110** proximate a given terminal **112a-d** and coordinate connection/disconnection with the displacement devices **130a-d**.

In use, the control system **102** can operate to connect/disconnect the terminal **110** with any of the terminals **112a-d**. In general, the displacement device **120** can actuate to position the carriage **140** at one of several discrete locations to locate the terminal **110** over or proximate a selected mating terminal **112a-d**. The displacement device **130a-d** associated with the selected terminal **112a-d** can then actuate to draw the terminal **110** toward the mating terminal **112a-d** and engage (i.e., connect) the terminals. When desired, the displacement device **130a-d** can actuate to push the terminal **110** away from the mating terminal **112a-d** and disengage (i.e., disconnect) the terminal **110** from the terminal **112a-d**. This process can be repeated for connecting the terminal **110** to a different selected mating terminal **112a-d**. In an example of this operation, the terminal **110** can be connected to the terminal **112a**. In this case, the displacement device **120** can position the terminal **110** proximate the terminal **112a**. The displacement device **130a** can then actuate to connect the terminals **110**, **112a**. When desired, the displacement device **130a** can actuate to disconnect the terminals **110**, **112a**. The process can be repeated for connecting the terminal **110** to a different selected mating terminal **112b-d**. In one aspect, the control system **102** can be configured to enable direct operator control and/or to automatically control operation of the displacement devices **120**, **130a-d** for connecting/disconnecting the terminal **110** and the terminals **112a-d**, such as by executing a programmed sequence/duration of connections. The technology disclosed herein can therefore provide the capability to mechanically mux and/or demux any suitable number of transmission lines (e.g., power, communication signals, data, hydraulic and/or pneumatic control, etc.) to one transmission line with no human interaction during the mechanical interconnect switching process, which can drastically reduce time over a manual switching process.

FIG. **6** illustrates a mechanical input/output selector system **200**, in accordance with another example of the present disclosure. The system **200** is similar in many respects to the system **100** discussed above with regard to FIGS. **1-4**. For example, the system **200** can comprise a mechanical input/output selector **201**, and a control system **202** to control operation of the selector **201**. As with the selector **101** discussed above, the selector **201** can include a terminal **210** for a transmission line **211**, terminals **212a-d** for respective

transmission lines **213a-d**, a displacement device **220** operable to selectively position the terminal **210** proximate to any one of the terminals **212a-d**, a carriage **240** coupled to the displacement device **220** and that is supporting the terminal **210**, and a displacement device **230** operable to move the terminal **210** relative to the respective terminals **212a-d** to alternately connect and disconnect the terminal **210** and one of the terminals **212a-d**.

In contrast to the displacement devices **130a-d** discussed above, which are associated with the respective terminals **112a-d**, the displacement device **230** is associated with the carriage **240**. Thus, in the example shown in FIG. 6, the displacement device **230** is supported by, and moves with, the carriage **240**. The carriage **240** can include a base **240** and a movable platform **242**, which can be coupled to the terminal **210**. The displacement device **230** can be coupled to the base **241** and the movable platform **242** to cause movement of the movable platform **242** relative to the base **241** to connect and disconnect the terminal **210** and one of the terminals **212a-d**. Although only a single displacement device **230** is illustrated, it should be recognized that any suitable number or configuration of displacement devices can be utilized to cause relative movement between the movable platform **242** and the base **241**. In some examples, no displacement devices are associated with the terminals **212a-d**. Thus, instead of displacement devices associated with the individual terminals **212a-d** (similar to the example shown in FIGS. 1 and 2), the displacement device **230** is associated and movable with the carriage **240** to cause connection/disconnection of the terminal **210** and the terminals **212a-d**. Accordingly, a support frame **270** can support various components of the system **200**, such as the displacement device **220** and the terminals **230a-d**, need not be configured to accommodate displacement devices below the terminals **212a-d**.

Although the arrangement of the terminals **112a-d**, **212a-d** and the movement path of the terminals **110**, **210** caused by the displacement devices **120**, **220** are represented in the figures as linear, it should be recognized that the arrangement of terminals **112a-d**, **212a-d** can be non-linear (e.g., curved) and that the displacement devices **120**, **220** can move the respective terminals **110**, **210** along any suitable path or paths to enable connecting with the terminals **112a-d**, **212a-d**.

In accordance with one example of the present invention, a method for facilitating input/output selection is disclosed. The method can comprise providing a mechanical input/output selector comprising a first terminal for a first transmission line, a plurality of second terminals for a plurality of second transmission lines, a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals, and a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals. Additionally, the method can comprise facilitating control of the first and second displacement devices. In one aspect, facilitating control of the first and second displacement devices comprises providing a control system. In another aspect, the method can further comprise providing a position sensor to provide position feedback data for positioning the first terminal. It is noted that no specific order is required in this method, though generally in one example, these method steps can be carried out sequentially.

Reference was made to the examples illustrated in the drawings and specific language was used herein to describe

the same. It will nevertheless be understood that no limitation of the scope of the technology is thereby intended. Alterations and further modifications of the features illustrated herein and additional applications of the examples as illustrated herein are to be considered within the scope of the description.

Although the disclosure may not expressly disclose that some examples or features described herein may be combined with other examples or features described herein, this disclosure should be read to describe any such combinations that would be practicable by one of ordinary skill in the art. The user of "or" in this disclosure should be understood to mean non-exclusive or, i.e., "and/or," unless otherwise indicated herein.

Furthermore, the described features, structures, or characteristics may be combined in any suitable manner in one or more examples. In the preceding description, numerous specific details were provided, such as examples of various configurations to provide a thorough understanding of examples of the described technology. It will be recognized, however, that the technology may be practiced without one or more of the specific details, or with other methods, components, devices, etc. In other instances, well-known structures or operations are not shown or described in detail to avoid obscuring aspects of the technology.

Although the subject matter has been described in language specific to structural features and/or operations, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features and operations described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims. Numerous modifications and alternative arrangements may be devised without departing from the spirit and scope of the described technology.

What is claimed is:

1. A mechanical input/output selector, comprising:

- a first terminal for a first transmission line;
- a plurality of second terminals for a plurality of second transmission lines;
- a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals;
- a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals; and
- a carriage coupled to the first displacement device and supporting the first terminal, the carriage comprising a base coupled to the first displacement device, and a movable platform in support of the first terminal and movably coupled to the base, the movable platform being movable relative to the base by the second displacement device to connect and disconnect the first terminal and one of the plurality of second terminals.

2. The mechanical input/output selector of claim 1, wherein the first terminal and the plurality of second terminals each comprise at least one connector.

3. The mechanical input/output selector of claim 1, wherein the at least one connector comprises an electrical connector, a fluid connector, a fiber optic connector, or a combination thereof.

4. The mechanical input/output selector of claim 3, wherein the fluid connector comprises a pneumatic connector, a hydraulic connector, or a combination thereof.

11

5. The mechanical input/output selector of claim 1, wherein at least one of the first and second displacement devices comprises a linear actuator.

6. The mechanical input/output selector of claim 5, wherein the linear actuator comprises a linear positioning system, an electric actuator, a hydraulic actuator, a pneumatic actuator, or a combination thereof.

7. The mechanical input/output selector of claim 1, further comprising a support frame in support of the first displacement device, the second displacement device, the plurality of second terminals, or a combination thereof.

8. The mechanical input/output selector of claim 7, further comprising a guide pin to facilitate correct alignment when connecting the first terminal and one of the plurality of second terminals.

9. The mechanical input/output selector of claim 8, wherein the guide pin is associated with the movable platform or the support frame and is operable to interface with a sidewall of a guide opening in the other of the movable platform or the support frame.

10. The mechanical input/output selector of claim 1, wherein the second displacement device comprises a plurality of second displacement devices each associated with one of the plurality of second terminals.

11. The mechanical input/output selector of claim 10, wherein the movable platform comprises an interface opening, and each of the plurality of second displacement devices comprises a platform interface configured to be received within the interface opening to facilitate coupling the plurality of second displacement devices with the movable platform.

12. The mechanical input/output selector of claim 11, wherein the platform interface comprises a rail configuration.

13. The mechanical input/output selector of claim 1, wherein the second displacement device is associated with the carriage.

14. A mechanical input/output selector system, comprising:

- a mechanical input/output selector comprising
 - a first terminal for a first transmission line,
 - a plurality of second terminals for a plurality of second transmission lines;
 - a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals, and
 - a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals;

12

a carriage coupled to the first displacement device and supporting the first terminal, the carriage comprising a base coupled to the first displacement device, and a movable platform in support of the first terminal and movably coupled to the base, the movable platform being movable relative to the base by the second displacement device to connect and disconnect the first terminal and one of the plurality of second terminals; and

a control system to control operation of the first and second displacement devices.

15. The system of claim 14, further comprising a position sensor to provide position feedback data for the control system to position the first terminal.

16. The system of claim 14, wherein the control system is configured to automatically control operation of the first and second displacement devices.

17. A method for facilitating input/output selection, comprising:

- providing a mechanical input/output selector comprising
 - a first terminal for a first transmission line,
 - a plurality of second terminals for a plurality of second transmission lines,
 - a first displacement device operable to selectively position the first terminal proximate to any one of the plurality of second terminals, and
 - a second displacement device operable to move the first terminal relative to the plurality of second terminals to alternately connect and disconnect the first terminal and one of the plurality of second terminals;
- a carriage coupled to the first displacement device and supporting the first terminal, the carriage comprising a base coupled to the first displacement device, and a movable platform in support of the first terminal and movably coupled to the base, the movable platform being movable relative to the base by the second displacement device to connect and disconnect the first terminal and one of the plurality of second terminals; and
- facilitating control of the first and second displacement devices.

18. The method of claim 17, wherein facilitating control of the first and second displacement devices comprises providing a control system.

19. The method of claim 17, further comprising providing a position sensor to provide position feedback data for positioning the first terminal.

* * * * *